



# wwPDB X-ray Structure Validation Summary Report ⓘ

May 26, 2020 – 10:45 am BST

PDB ID : 4MKY  
Title : Polymerase Domain from Mycobacterium tuberculosis Ligase D in complex with an annealed double-strand DNA break.  
Authors : Brissett, N.C.; Doherty, A.J.  
Deposited on : 2013-09-05  
Resolution : 2.40 Å(reported)

This is a wwPDB X-ray Structure Validation Summary Report for a publicly released PDB entry.

We welcome your comments at [validation@mail.wwpdb.org](mailto:validation@mail.wwpdb.org)

A user guide is available at

<https://www.wwpdb.org/validation/2017/XrayValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

---

The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity	:	4.02b-467
Xtriage (Phenix)	:	1.13
EDS	:	2.11
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.11

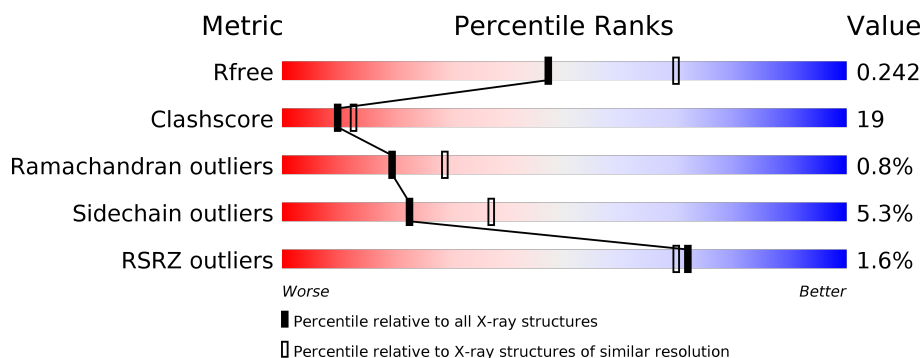
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

## *X-RAY DIFFRACTION*

The reported resolution of this entry is 2.40 Å.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
$R_{free}$	130704	3907 (2.40-2.40)
Clashscore	141614	4398 (2.40-2.40)
Ramachandran outliers	138981	4318 (2.40-2.40)
Sidechain outliers	138945	4319 (2.40-2.40)
RSRZ outliers	127900	3811 (2.40-2.40)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments on the lower bar indicate the fraction of residues that contain outliers for  $\geq 3$ , 2, 1 and 0 types of geometric quality criteria respectively. A grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions  $\leq 5\%$ . The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density. The numeric value is given above the bar.

Mol	Chain	Length	Quality of chain
1	A	303	<div> <div>66%</div> <div>25%</div> <div>6%</div> </div>
1	B	303	<div>3%</div> <div>64%</div> <div>25%</div> <div>7%</div>

*Continued on next page...*

*Continued from previous page...*

Mol	Chain	Length	Quality of chain
2	I	5	 40% 20% 40%
2	K	5	 40% 20% 40%
3	F	10	 30% 70%
3	H	10	 20% 80%
3	J	10	 20% 80%
3	L	10	 40% 60%

## 2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 9936 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, the ZeroOcc column contains the number of atoms modelled with zero occupancy, the AltConf column contains the number of residues with at least one atom in alternate conformation and the Trace column contains the number of residues modelled with at most 2 atoms.

- Molecule 1 is a protein called DNA ligase-like protein Rv0938/MT0965.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	284	Total	C	N	O	S	0	0	0
			2172	1372	387	408	5			
1	B	283	Total	C	N	O	S	0	0	0
			2164	1368	386	405	5			
1	C	284	Total	C	N	O	S	0	0	0
			2172	1372	387	408	5			
1	D	284	Total	C	N	O	S	0	0	0
			2172	1372	387	408	5			

There are 12 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1	GLY	-	EXPRESSION TAG	UNP P71571
A	2	SER	-	EXPRESSION TAG	UNP P71571
A	3	HIS	-	EXPRESSION TAG	UNP P71571
B	1	GLY	-	EXPRESSION TAG	UNP P71571
B	2	SER	-	EXPRESSION TAG	UNP P71571
B	3	HIS	-	EXPRESSION TAG	UNP P71571
C	1	GLY	-	EXPRESSION TAG	UNP P71571
C	2	SER	-	EXPRESSION TAG	UNP P71571
C	3	HIS	-	EXPRESSION TAG	UNP P71571
D	1	GLY	-	EXPRESSION TAG	UNP P71571
D	2	SER	-	EXPRESSION TAG	UNP P71571
D	3	HIS	-	EXPRESSION TAG	UNP P71571

- Molecule 2 is a DNA chain called 5'-D(P\*DGP\*DCP\*DGP\*DGP\*DC)-3'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	E	3	Total	C	N	O	P	0	0	0
			64	29	13	19	3			
2	G	3	Total	C	N	O	P	0	0	0
			64	29	13	19	3			

*Continued on next page...*

*Continued from previous page...*

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	I	3	Total	C	N	O	P	0	0	0
			64	29	13	19	3			
2	K	3	Total	C	N	O	P	0	0	0
			64	29	13	19	3			

- Molecule 3 is a DNA chain called 5'-D(\*DGP\*DCP\*DCP\*DGP\*DCP\*DAP\*DGP\*DTP\*DAP\*DC)-3'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	F	10	Total	C	N	O	P	0	0	0
			201	96	39	57	9			
3	H	10	Total	C	N	O	P	0	0	0
			201	96	39	57	9			
3	J	10	Total	C	N	O	P	0	0	0
			201	96	39	57	9			
3	L	10	Total	C	N	O	P	0	0	0
			201	96	39	57	9			

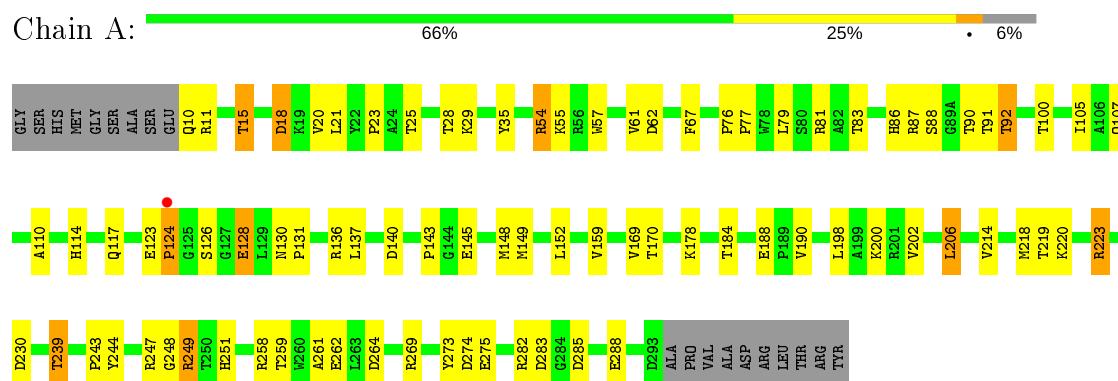
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	48	Total	O	0	0
			48	48		
4	B	23	Total	O	0	0
			23	23		
4	C	40	Total	O	0	0
			40	40		
4	D	56	Total	O	0	0
			56	56		
4	G	1	Total	O	0	0
			1	1		
4	K	2	Total	O	0	0
			2	2		
4	F	7	Total	O	0	0
			7	7		
4	H	7	Total	O	0	0
			7	7		
4	J	5	Total	O	0	0
			5	5		
4	L	7	Total	O	0	0
			7	7		

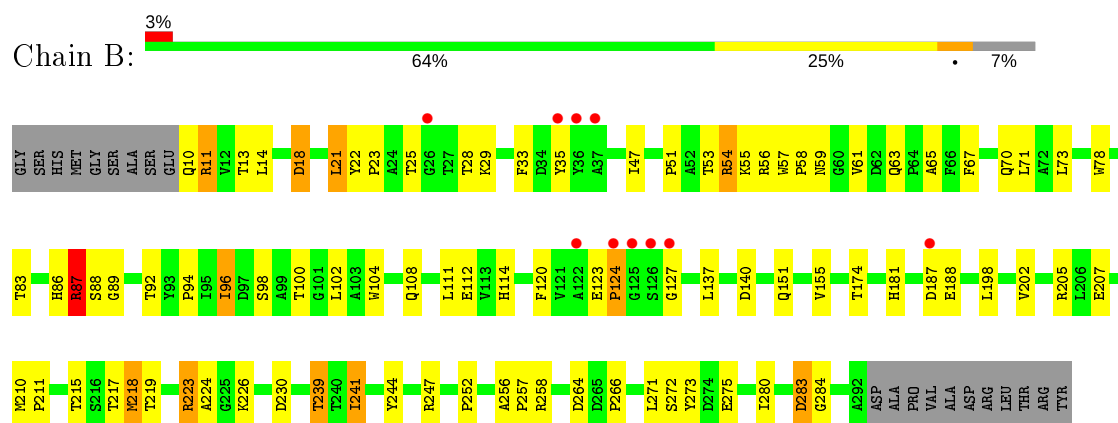
### 3 Residue-property plots

These plots are drawn for all protein, RNA and DNA chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. A red dot above a residue indicates a poor fit to the electron density ( $RSRZ > 2$ ). Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

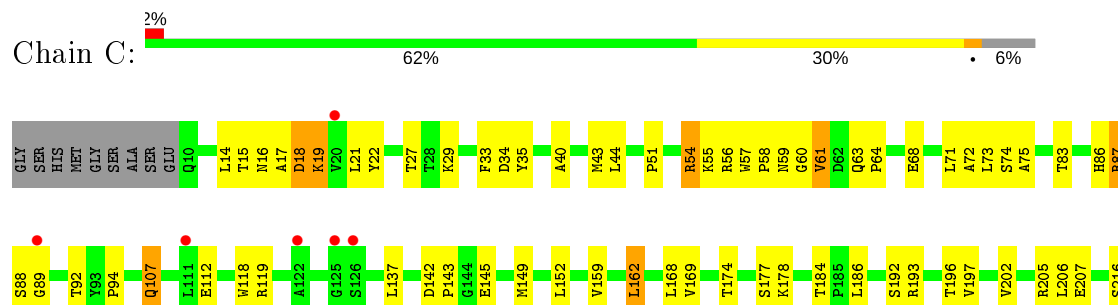
- Molecule 1: DNA ligase-like protein Rv0938/MT0965



- Molecule 1: DNA ligase-like protein Rv0938/MT0965

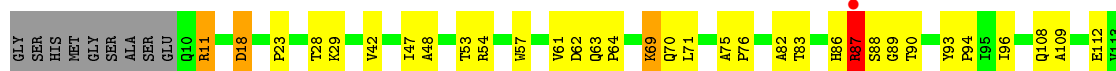


- Molecule 1: DNA ligase-like protein Rv0938/MT0965





- Molecule 1: DNA ligase-like protein Rv0938/MT0965



- Molecule 2: 5'-D(P\*DGP\*DCP\*DGP\*DGP\*DC)-3'



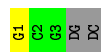
- Molecule 2: 5'-D(P\*DGP\*DCP\*DGP\*DGP\*DC)-3'



- Molecule 2: 5'-D(P\*DGP\*DCP\*DGP\*DGP\*DC)-3'



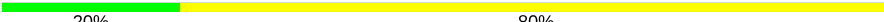
- Molecule 2: 5'-D(P\*DGP\*DCP\*DGP\*DGP\*DC)-3'



- Molecule 3: 5'-D(\*DGP\*DCP\*DCP\*DGP\*DCP\*DAP\*DGP\*DTP\*DAP\*DC)-3'



- Molecule 3: 5'-D(\*DGP\*DCP\*DCP\*DGP\*DCP\*DAP\*DGP\*DTP\*DAP\*DC)-3'

Chain H:  20% 80%



● Molecule 3: 5'-D(\*DGP\*DCP\*DCP\*DGP\*DCP\*DAP\*DGP\*DTP\*DAP\*DC)-3'

Chain J:  20% 80%



● Molecule 3: 5'-D(\*DGP\*DCP\*DCP\*DGP\*DCP\*DAP\*DGP\*DTP\*DAP\*DC)-3'

Chain L:  40% 60%





## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	87.58Å 80.11Å 118.39Å 90.00° 111.62° 90.00°	Depositor
Resolution (Å)	37.64 – 2.40 37.64 – 2.40	Depositor EDS
% Data completeness (in resolution range)	98.1 (37.64-2.40) 98.1 (37.64-2.40)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	0.12	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.17 (at 2.39Å)	Xtriage
Refinement program	REFMAC	Depositor
R, $R_{free}$	0.197 , 0.245 0.197 , 0.242	Depositor DCC
$R_{free}$ test set	2988 reflections (5.07%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	40.4	Xtriage
Anisotropy	0.638	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.32 , 24.2	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.41$ , $\langle L^2 \rangle = 0.24$	Xtriage
Estimated twinning fraction	0.289 for h,-k,-h-l	Xtriage
Reported twinning fraction	0.710 for H, K, L 0.290 for H, -K, -H-L	Depositor
Outliers	1 of 58942 reflections (0.002%)	Xtriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	9936	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	46.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 18.60% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical values of  $\langle |L| \rangle$ ,  $\langle L^2 \rangle$  for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

## 5 Model quality

### 5.1 Standard geometry

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with  $|Z| > 5$  is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	# $ Z  > 5$	RMSZ	# $ Z  > 5$
1	A	0.49	0/2222	0.69	0/3035
1	B	0.44	0/2214	0.61	0/3024
1	C	0.47	0/2222	0.67	0/3035
1	D	0.60	0/2222	0.78	1/3035 (0.0%)
2	E	1.29	1/71 (1.4%)	0.66	0/106
2	G	1.27	1/71 (1.4%)	0.76	0/106
2	I	1.27	1/71 (1.4%)	0.70	0/106
2	K	1.39	1/71 (1.4%)	0.81	0/106
3	F	0.32	0/225	0.75	0/345
3	H	0.29	0/225	0.69	0/345
3	J	0.33	0/225	0.76	0/345
3	L	0.37	0/225	0.79	0/345
All	All	0.53	4/10064 (0.0%)	0.70	1/13933 (0.0%)

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	K	1	DG	OP3-P	-10.79	1.48	1.61
2	I	1	DG	OP3-P	-10.35	1.48	1.61
2	E	1	DG	OP3-P	-10.35	1.48	1.61
2	G	1	DG	OP3-P	-9.98	1.49	1.61

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	D	258	ARG	NE-CZ-NH2	-5.75	117.42	120.30

There are no chirality outliers.

There are no planarity outliers.

## 5.2 Too-close contacts ⓘ

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	2172	0	2176	68	0
1	B	2164	0	2172	95	0
1	C	2172	0	2176	83	1
1	D	2172	0	2176	71	0
2	E	64	0	34	5	0
2	G	64	0	34	1	0
2	I	64	0	34	5	0
2	K	64	0	34	0	0
3	F	201	0	113	18	1
3	H	201	0	113	15	0
3	J	201	0	113	16	1
3	L	201	0	113	20	0
4	A	48	0	0	4	1
4	B	23	0	0	5	0
4	C	40	0	0	2	0
4	D	56	0	0	8	0
4	F	7	0	0	3	0
4	G	1	0	0	0	0
4	H	7	0	0	1	0
4	J	5	0	0	3	0
4	K	2	0	0	0	0
4	L	7	0	0	0	0
All	All	9936	0	9288	366	2

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 19.

The worst 5 of 366 close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
3:F:7:DG:N2	3:H:10:DC:N3	1.66	1.41
1:C:29:LYS:NZ	2:I:1:DG:OP1	1.74	1.19
1:A:249:ARG:HG2	1:A:249:ARG:HH11	1.04	1.16
3:J:8:DT:O4	3:L:9:DA:N6	1.83	1.12
1:B:241:ILE:H	1:B:241:ILE:HD12	1.11	1.12

All (2) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:C:87:ARG:O	4:A:423:HOH:O[1_565]	1.94	0.26
3:F:2:DC:O2	3:J:1:DG:N2[2_646]	2.19	0.01

## 5.3 Torsion angles [i](#)

### 5.3.1 Protein backbone [i](#)

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the backbone conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	A	282/303 (93%)	265 (94%)	15 (5%)	2 (1%)	22	32
1	B	281/303 (93%)	262 (93%)	16 (6%)	3 (1%)	14	20
1	C	282/303 (93%)	264 (94%)	16 (6%)	2 (1%)	22	32
1	D	282/303 (93%)	260 (92%)	20 (7%)	2 (1%)	22	32
All	All	1127/1212 (93%)	1051 (93%)	67 (6%)	9 (1%)	19	29

5 of 9 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	18	ASP
1	C	18	ASP
1	C	87	ARG
1	D	87	ARG
1	D	150	ALA

### 5.3.2 Protein sidechains [i](#)

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the sidechain conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	A	228/242 (94%)	215 (94%)	13 (6%)	20	33
1	B	227/242 (94%)	214 (94%)	13 (6%)	20	33
1	C	228/242 (94%)	218 (96%)	10 (4%)	28	45
1	D	228/242 (94%)	216 (95%)	12 (5%)	22	37
All	All	911/968 (94%)	863 (95%)	48 (5%)	22	37

5 of 48 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	218	MET
1	C	19	LYS
1	D	151	GLN
1	B	223	ARG
1	B	241	ILE

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 13 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	251	HIS
1	C	16	ASN
1	D	130	ASN
1	B	181	HIS
1	D	114	HIS

### 5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

## 5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

There are no non-standard protein/DNA/RNA residues in this entry.

## 5.5 Carbohydrates ⓘ

There are no carbohydrates in this entry.

## 5.6 Ligand geometry [i](#)

There are no ligands in this entry.

## 5.7 Other polymers [i](#)

There are no such residues in this entry.

## 5.8 Polymer linkage issues [i](#)

There are no chain breaks in this entry.

## 6 Fit of model and data [i](#)

### 6.1 Protein, DNA and RNA chains [i](#)

In the following table, the column labelled ‘#RSRZ> 2’ contains the number (and percentage) of RSRZ outliers, followed by percent RSRZ outliers for the chain as percentile scores relative to all X-ray entries and entries of similar resolution. The OWAB column contains the minimum, median, 95<sup>th</sup> percentile and maximum values of the occupancy-weighted average B-factor per residue. The column labelled ‘Q< 0.9’ lists the number of (and percentage) of residues with an average occupancy less than 0.9.

Mol	Chain	Analysed	<RSRZ>	#RSRZ>2	OWAB(Å <sup>2</sup> )	Q<0.9
1	A	284/303 (93%)	-0.23	1 (0%) 92 91	23, 39, 61, 79	0
1	B	283/303 (93%)	0.13	10 (3%) 44 43	30, 50, 81, 95	0
1	C	284/303 (93%)	0.02	6 (2%) 63 61	27, 45, 77, 90	0
1	D	284/303 (93%)	-0.31	2 (0%) 87 86	21, 32, 45, 60	0
2	E	3/5 (60%)	-0.55	0 100 100	61, 61, 64, 65	0
2	G	3/5 (60%)	-0.98	0 100 100	48, 48, 50, 53	0
2	I	3/5 (60%)	-0.46	0 100 100	65, 65, 65, 66	0
2	K	3/5 (60%)	-0.23	0 100 100	41, 41, 44, 51	0
3	F	10/10 (100%)	-0.30	0 100 100	63, 73, 76, 83	0
3	H	10/10 (100%)	-0.51	0 100 100	49, 57, 81, 81	0
3	J	10/10 (100%)	-0.35	0 100 100	61, 69, 77, 78	0
3	L	10/10 (100%)	-0.10	0 100 100	43, 54, 78, 80	0
All	All	1187/1272 (93%)	-0.11	19 (1%) 72 70	21, 41, 76, 95	0

The worst 5 of 19 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	126	SER	4.4
1	B	26	GLY	4.4
1	C	125	GLY	4.1
1	B	124	PRO	3.6
1	C	122	ALA	3.6

### 6.2 Non-standard residues in protein, DNA, RNA chains [i](#)

There are no non-standard protein/DNA/RNA residues in this entry.

### 6.3 Carbohydrates [i](#)

There are no carbohydrates in this entry.

### 6.4 Ligands [i](#)

There are no ligands in this entry.

### 6.5 Other polymers [i](#)

There are no such residues in this entry.